EVALUATION OF METHYL ANTHRANILATE AND DRC-156 AS CANADA GOOSE GRAZING REPELLENTS

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Abstract: We applied methyl anthranilate (MA) and DRC-156 to grass plots within an enclosure to evaluate their effectiveness as a repellent for Canada geese (*Branta canadensis*). Economically similar application rates of 9 kg/ha and 16 kg/ha for MA and DRC-156, respectively, were significant in reducing goose activity on treated grass plots. DRC-156 appeared to offer much better repellency for a longer period of time (40 days).

Key words: anthranilate, *Branta canadensis*, Canada goose, feeding, grass, repellent, taste.

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Many Canada goose populations in North American are increasing. For example, the Mississippi Flyway Council reported a 148% increase in the number of Canada geese during mid-December surveys from 1980 to 1989 (Babcock et al. 1990). Numbers rose from 745,000 to 1,850,000 during this period. While these population increases are an important step in the conservation of waterfowl, Canada geese also are implicated in habitat destruction, crop depredation, and nuisance problems (Williams and Bishop 1990). Foraging urban and suburban geese damage grass in parks, backyards, and on golf courses (Laycock 1982). Feces left by geese reduce the aesthetic value and recreational use of these areas and negatively impact water quality and public health (Conover and Chasko 1985, Mott and Timbrook 1988).

Management techniques used to reduce nuisance goose problems include pyrotechnic devices, traps, nest destruction, hunting, and mechanical scare devices (USDA 1986, Aguilera et al. 1991). However, the use of these techniques is limited by cost, logistics, and/or effectiveness. These limitations have stimulated efforts to develop effective, economical, and environmentally safe chemical repellents which deter foraging geese. Two potentially appropriate repellents are methyl anthranilate (MA, CAS 134-20-3) and DRC-156. MA is registered with the U.S. Food and Drug Administration as a flavor additive for human and animal foods. In addition, at concentrations between 1.0% and 2.0% (Cummings et al. 1992) it is offensive to waterfowl. DRC-156 has shown repellency to passerines at 1.0% concentrations (Schafer et al. 1983); however, its repellency effects on waterfowl are unknown.

In a recent field test of goose grazing repellents (Cummings et al. 1991), dimethyl anthranilate (DMA) and MA were applied at a 3.4 kg/ha active ingredient rate to 5 grassy areas in New Jersey frequented by Canada geese. Control plots had 3 times greater bird use and fecal deposits than treated plots; however, the differences were not statistically significant. Large variations in the number of geese and fecal deposits within sites suggested problems with the chemical concentration and that the compounds were unable to produce consistently aversive responses by geese.

Because the compounds fell short of our expectations, we felt that additional evaluations of MA encapsulation formulations, concentration levels, and application rates were warranted under simulated field conditions. The objective of the present study was to evaluate the repellency of MA and DRC-156 to Canada geese when applied in pen trials to grass. We thank M. L. Avery, R. A. Dolbeer, R. L. Knight, and J. R. Mason for providing technical assistance and critical review of earlier manuscript drafts.

MATERIALS AND TREATMENT APPLICATION

We obtained a 31% concentrate of MA entrapped in 2 micro encapsulation matrices to reduce chemical volatility and photodegradation (Encapsulation Technologies, Nyack, N.Y.). Different encapsulation matrices vary the rate of chemical release. Formulation 1 produced a delayed release when contacted by geese; formulation 2 produced an instant release. DRC-156 wettable granules (75% concentrate) were obtained from W. A. Cleary (Sommerset, N.J.). Eighty adult Canada geese of undetermined sex were cannon-netted (Dill and Thornsberry 1950) on the grounds of the Denver Federal Center, Denver, Colorado, in June 1989. Geese were housed in 2 outdoor pens (8 x 4 x 2 m) with free access to shelled corn, Purina Gamebird Chow, and water for an acclimation period of 4 weeks.

We divided a 40 x 120 m grass enclosure at the Denver Federal Center into 6 equal units containing water and shelter and separated by a 2-m woven wire fence. Within each unit, 2 14 x 14 m Kentucky bluegrass (*Poa pratensis*) plots were established (Fig. 1). Grass plots were the only food source for penned geese. Each plot was separated by a 3-6 m buffer zone (bare ground) to help birds visually distinguish between plots and thus reduce the chance of treatment bias. Plots were watered every 2 days (2 hr) and mowed every 7 days.

We conducted 5 separate experiments involving MA and DRC-156 from August to December 1989. They included the following: Experiment 1—MA formulation 1 applied at 5 kg/ha, Experiment 2—MA formulation 1 applied at 9 kg/ha, Experiment 3—MA formulation 2 applied at 9 kg/ha, Experiment 4—DRC-156 applied at 16 kg/ha, and Experiment 5—geese from Experiment 4 were removed and new geese were introduced into the same units. We used 2 units each for experiments 1 and 2, and 3 units each for experiments 3, 4, and 5. We only reused units if grass plots were replaced, the plots showed no signs of chemical residues, or geese showed no preference for either plot.

We sprayed each plot chosen for treatment once with MA or DRC-156 at its assigned application rate with a boom-type sprayer. Both chemicals were formulated with 99.7% water and 0.3% sticker. The spraying apparatus was calibrated pre- and posttreatment following methods described by O'Neal et al. (1984). The same equipment was used for all applications. We first sprayed control plots at the same application rates with the formulation (minus MA or DRC-156) to prevent any possible contamination of the sprayer from the treated formulation. All equipment was cleaned thoroughly after each application.

EXPERIMENTAL DESIGN AND DATA ANALYSIS

The basic experimental unit in the design consisted of 2 plots. Units were used as a blocking factor. One plot within each unit was randomly selected to receive treatment and the other plot served as a control.

Seven days prior to the start of each experiment, 6 geese were randomly selected from the captive population and released into each unit to acclimate to their surroundings. Each goose had its primary wing feathers trimmed to prevent escape from the enclosure. Geese remained in these units for 10-20 days after treatment application (posttreatment). If, after 20 days, signs of repellency were observed from treated plots, another group of 6 geese was introduced into the units for 20 days. The experiments were concluded a maximum of 40 days posttreatment.

Observations of geese began 6 days before treatment application (pretreatment) on each unit and continued daily until the conclusion of respective experiments. Observations included recording the number of geese in each plot at 5-min intervals for 60 min between 0700 and 0900 and 1400 and 1600 hr. We collected data from all plots during a single 60-min period, each day, from an elevated blind on the edge of the enclosure which permitted unobstructed views of all plots without disturbance of any geese (Fig. 1). Daily counts were summed by plot to produce an index of bird use.

To estimate the amount of fecal deposits on each plot, we divided plots into 2 strata of equal width (7 m). Within each stratum, we randomly located 2 transects parallel to a center buffer zone. Transects were 50 cm wide and were marked at each end by spikes. To delineate transects during fecal deposit collections, strings were strung between the spikes. Prior to the start of each experiment, the transect and a 1-m swath on either side of the transect was completely cleared of all goose fecal deposits using a Little Wonder 8-hp blower (Little Wonder Company, Southhampton, Pa.).

Fecal deposits were collected every 2 days from each transect starting 6 days pretreatment and ending at the conclusion of the respective experiments. Fecal material was immediately transferred to a dryer and dried at 82 C for 24 hr and weighed. We converted fecal deposit weights to g/plot for each unit and day.

We used PROC GLM (SAS Inst. Inc. 1987) and a 3-factor analysis of variance (ANOVA) to test treatment differences in bird numbers and goose fecal deposit weights. Principle factors affecting the ANOVA were blocks (units), treatment, and day of

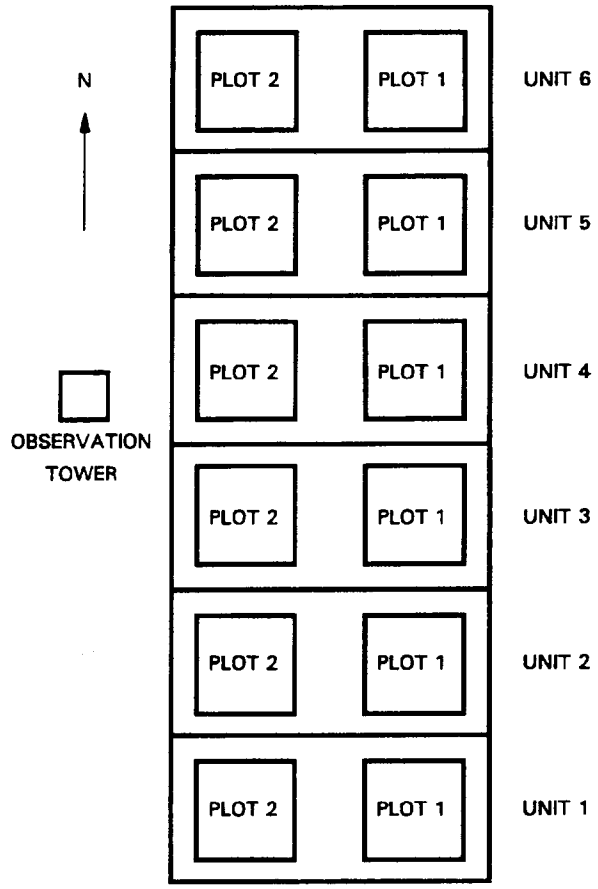


Figure 1. Waterfowl testing enclosure divided into 6 units. Each unit was divided into 2 14 x 14 m grass plots.

posttreatment which was treated as a repeated measure. The acceptable level of statistical significance was established at 0.05.

RESULTS

Experiment 1

For both bird numbers and fecal deposits there were no significant differences between treatments ($F = 0.5$; 1, 1df; $P = 0.61$) ($F = 0.1$; 1, 1 df; $P = 0.82$) and the treatment-by-day interactions ($F = 0.5$; 1, 1 df; $P = 0.088$; $F = 0.3$; 4, 4 df; $P = 0.34$), respectively. However, there were significant differences among days ($F = 4.8$; 11, 11 df; $P < 0.01$; $F = 8.6$; 4, 4 df; $P = 0.03$) (Fig. 2).

Experiment 2

For bird numbers there were borderline significant differences between treatments ($F = 109.7$; 1, 1 df; $P = 0.06$)), but no significant treatment-by-day interactions ($F = 1.49$; 21, 21 df; $P = 0.19$). However, there were significant differences among days ($F = 4.7$; 21, 21 df; $P < 0.01$) (Fig 2). For fecal deposits, there were significant differences between treatments ($F = 1{,}069.0$; 1, 1 df; $P = 0.02$), days ($F = 16.4$; 9, 9 df; $P < 0.01$), and treatment by day interactions ($F = 16.0$; 9, 9 df; $P < 0.01$) (Fig. 2).

Experiment 3

For bird numbers there were no significant differences between treatments ($F = 3.7$; 1, 2 df; $P = 0.19$). However, there were significant differences among days ($F = 17.9$; 11, 22 df; $P < 0.01$) and the treatment-by-day interactions ($F = 2.8$; 11, 22 df; $P = 0.02$) (Fig. 2). For fecal deposits there were significant differences between treatments ($F = 19.5$; 1, 2 df; $P = 0.05$) and days ($F = 5.5$; 5, 10 df; $P = 0.01$). There was no significant interaction between treatments and days ($F = 1.8$; 5, 10 df; $P = 0.19$) (Fig. 2).

Experiment 4

For both bird numbers and fecal deposits there were significant differences between treatments ($F = 109.0$; 1, 2 df; $P < 0.01$; $F = 22.0$; 1, 2 df; $P = 0.04$), days ($F=9.5$; 19, 38 df; $P < 0.01$; $F=29.9$; 8, 16 df; $P < 0.01$), and treatment-by-day interactions ($F = 4.9$; 19, 38 df; $P < 0.01$), respectively (Fig. 3).

Experiment 5

For both bird numbers and fecal deposits there were significant differences between treatments ($F = 3{,}374.6$; 1, 2 df; $P < 0.01$; $F = 4.26$; 1, 2 df; $P = 0.02$) and days ($F = 4.7$; 19, 38 df; $P < 0.01$; $F = 5.2$; 7, 14 df; $P < 0.01$), respectively. There was a significant treatment-by-day interaction for bird observations ($F = 2.5$; 19, 38 df; $P < 0.01$), but not for fecal deposits ($F = 1.4$; 7, 14 df; $P = 0.29$) (Fig. 3).

DISCUSSION

In our experiments the repellency of MA to Canada geese was affected by both formulation and application rate. While MA applied at 5 kg/ha (Exp. 1) was not effective in causing geese to avoid treated grass plots, data suggested that the same formulation applied at 9 kg/ha (Exp. 2) repelled geese. However, the repellency of this higher application rate of MA showed signs of decreased effectiveness 7-10 days posttreatment. The combination of environmental factors and irrigation (1.0 cm) every 2 days could have accelerated the natural breakdown of the encapsulation matrix. In studies conducted in New Jersey, MA concentrations degraded 19% at 7-14 days posttreatment and 47% after 28 days when exposed to ambient outdoor conditions (Cummings et al. 1991).

In Experiment 3, MA formulation 2, there were significantly fewer feces on treated plots. However, birds continued to enter the treated area, suggesting that MA concentrations were not sufficiently high to

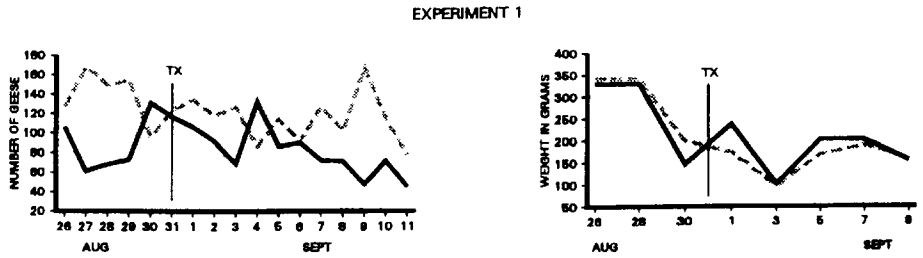
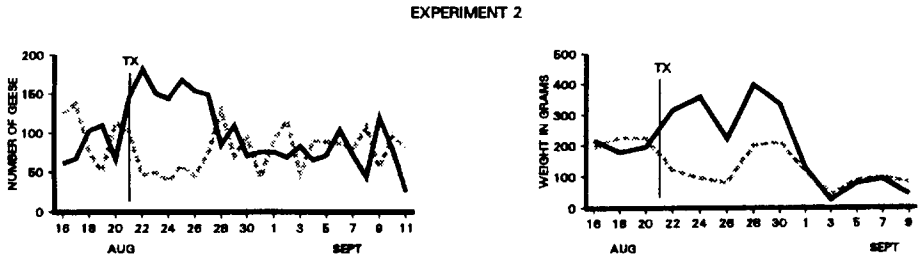
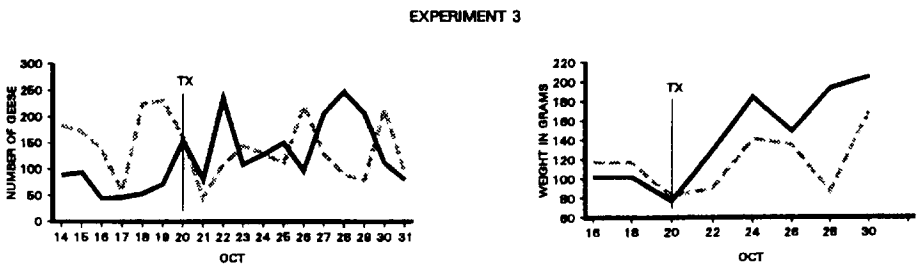
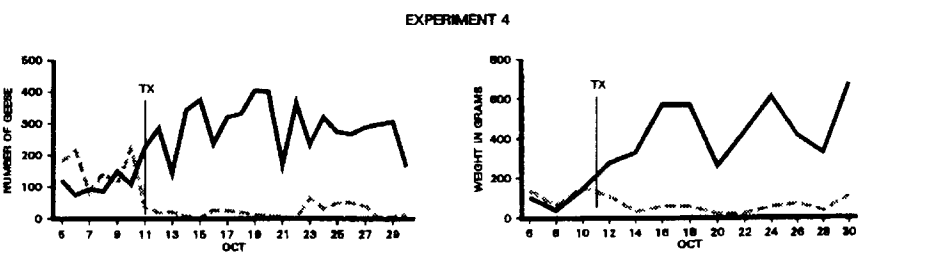


Figure 2. Total number of Canada geese and fecal deposits (g) on grass plots treated with methyl anthranilate (MA). Experiment 1—MA formulation 1 applied at 5 kg/ha, Experiment 2—MA formulation 1 applied at 9 kg/ha, and Experiment 3—MA formulation 2 applied at 9 kg/ha. TX notes treatment day.







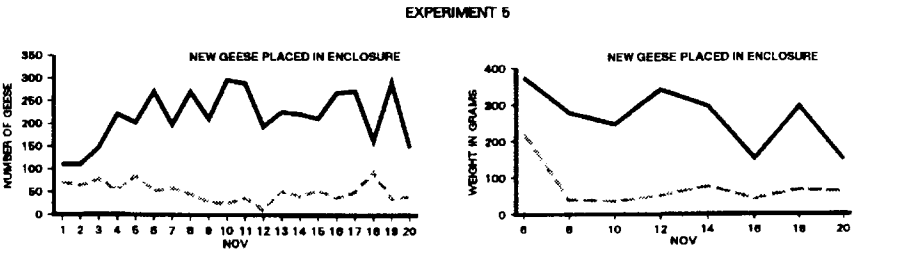
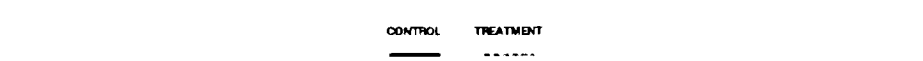


Figure 3. Total number of Canada geese and fecal deposits (g) on grass plots treated with DRC-156. Experiment 4—DRC-156 applied at 16 kg/ha and Experiment 5—geese from Experiment 4 were removed and new geese were introduced into the same units. TX notes treatment day.



cause complete avoidance of treated grass plots. It is possible that the thin-walled encapsulation matrix was damaged during application, causing rapid and substantial release of MA.

MA is a chemosensory repellent acting through taste, olfaction, and the common chemical sense (Mason et al. 1989). It has no aversive postingestional effect that might cause food avoidance learning (J. R. Mason, USDA/APHIS/ADC, pers. commun.). In our experiments, the geese continued to sample MA-treated grass, and avoided it when effective repellency levels were maintained. As MA concentrations degraded below the goose repellency threshold, foraging activity resumed.

In Experiments 4 and 5, DRC-156 was effective in reducing activity on treated grass plots. Furthermore, we observed a relatively fast response to the treatment (i.e., avoidance was observed in 2 days). The level of repellency attained in Experiment 4 was maintained in Experiment 5 even though there was no additional chemical treatment. We suspect that DRC-156 caused an aversion to treated grass plots because of its aversive postingestive effects (sickness) and aversive chemosensory properties (E. W. Schafer, USDA/APHIS/ADC, pers. commun.).

MANAGEMENT IMPLICATIONS

Although both chemicals repelled geese at the experimental application rates, DRC-156 appeared to offer much better repellency for a longer period of time. At application rates of 9 kg/ha for MA and 16 kg/ha for DRC-156, chemicals are comparable in cost—MA ($7/kg) and DRC-156 ($4/kg). The strong aversion to DRC-156 suggests that the application rate could be lowered to 1/3 the tested rate and still show repellency (J. L. Cummings, USDA/APHIS/ADC, unpubl. data). Thus, there would be a distinct economical advantage of developing DRC-156 as a goose grazing repellent. The test rate (16 kg/ha) of DRC-156 would cost about $60/ha, an amount that turf managers would be willing to spend on a goose grazing repellent (D. L. Otis, Clemson Univ., unpubl. data).

We suggest that improvements in the encapsulation process might enhance the effectiveness of MA. A pressure-release capsule would release the chemical only when geese occupy a treated site. Thus, the longevity of the treatment could be prolonged on grass.

MA and DRC-156 are promising candidates as repellents for reducing goose activity on grass. Further tests are warranted to determine their efficacy under field conditions.

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